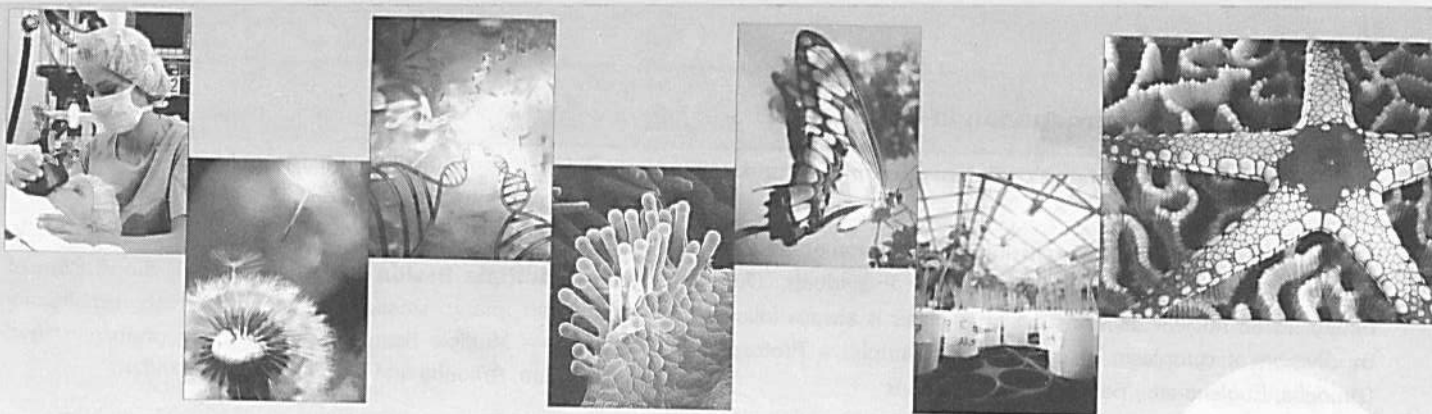




Chapter 6.1

Reproduction in Organisms

Life cycle and life span : In all metazoan animals, the life cycle includes two developmental period; embryonic period (pre-natal developmental period) which extends from zygote to offspring till hatching or birth, and post embryonic period (post-natal developmental period)- which includes growth, adulthood, reproduction, ageing. Thus, the life cycle comprises five main events : birth, growth, maturity, old age and death, that follow in the sequence named. Maximum life span is the maximum number of years survived by any member of a species, while average life span is the number of years survived by members of a population. Life expectancy is the age at which half the population still survives.

Table : 6.1-1 Life span in different organisms

S.No.	Animals name	Life span
1.	Mayfly	24 hours
2.	Silk moth	2-3 days
3.	Mouse	3-5 years
4.	Rats	4-6 years
5.	Humming bird	8 years
6.	Rabbits	13 years
7.	Monkeys	26 years
8.	Dog	20-30 years
9.	Bullfrog and Lion	30 years
10.	Toads	36 years
11.	Cat	28 years
12.	Chimpanzee	45 years
13.	Horses	60 years
14.	Man	60 years (during 1988-95 period – WHO report)
15.	Elephant	70 years
16.	Turkey	118 years
17.	Parrots	140 years
18.	Tortoise and banyan tree	200 years
19.	Sequoia	

Habit that influence life span : Life-style habits can influence life span considerably. Although a healthful diet does not guarantee immortality, regular exercise and avoiding of alcohol, smoking and drugs, contentment and freedom from stress can make a person's last years more pleasant.

Reproduction and its type

Reproduction : Reproduction is the ability of living organism to produce a new generation of living individuals similar to themselves.

Basic features of reproduction : All organisms reproduce. Modes of reproduction vary in different organisms. However, all modes have certain common basic features. These are

(1) Replication of DNA. This is the molecular basis of reproduction.

(2) Cell division, only mitotic, or both mitotic and meiotic. This is cytological basis of reproduction.

(3) Formation of reproductive bodies or units.

(4) Development of reproductive bodies into offspring.

Types of reproduction : These are of two main types

(1) Asexual (Non-gametic) (2) Sexual (gametic)

(1) **Asexual reproduction**

Definition : Production of offspring by a single parent without the formation and fusion of gametes is called asexual reproduction. The young one receives all its genes from one parent.

Asexual reproduction is also known as agamogenesis or agamogeny. It involves only mitotic cell divisions, and also termed somatogenic reproduction. Asexual reproduction produces identical offspring commonly referred to as a clone. Today, the scientists have been able to produce clones of multicellular animals (e.g., boar calf names as Frosty, and Finn Dorset lamb named as the famous Dolly) artificially in the laboratory.

Occurrence : Asexual reproduction occurs in protozoans and some lower animals such as sponges, coelenterates, certain worms and tunicates. It is absent among the higher non-vertebrates and all vertebrates.

Types : Asexual reproduction takes place in five principal ways :

(i) **Binary fission :** Binary fission is the division of the parent into two small, nearly equalized daughter individuals. During binary fission nuclear divisions or karyokinesis is always followed by division of cytoplasm or cytokinesis. Examples – Protozoans (*Amoeba*, *Euglena* etc.) Bacteria and Planarians.

Modes of binary fission : In Binary fission, the nucleus divides first and the cytoplasm next. Subsequently, the mother cell splits into two equal sized daughter halves or cells. There are three modes of binary fission.

(a) **Simple binary fission :** If the plane of cytoplasmic division passes through any direction, the fission is called simple fission. Example – *Amoeba*.

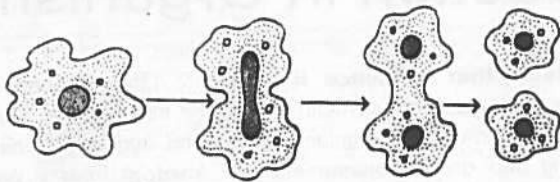


Fig : 6.1-1 Simple binary fission in amoeba

(b) **Transverse binary fission :** If the plane of cytoplasmic division coincides with the transverse axis of the individual, the fission is termed transverse binary division. Example – *Paramecium* and Planaria.

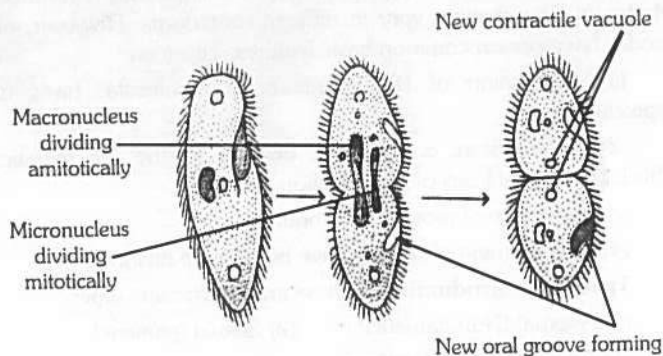


Fig : 6.1-2 Transverse binary fission in paramecium

(c) **Longitudinal binary fission :** If the plane of cytoplasmic division coincides with the longitudinal axis of the individual. This kind of fission is designated as longitudinal binary fission. Example *Euglena* and *vorticella*.

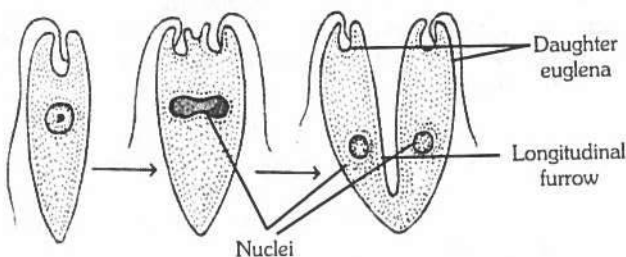


Fig : 6.1-3 Longitudinal binary fission in euglena

Binary fission involves mitosis only and consequently, the resultant offspring's are genetically identical to the parent and each other.

(ii) **Multiple fission :** Multiple fission is the division of the parent into many small daughter individuals simultaneously. Examples – Multiple fission occurs in many protozoans such as *Plasmodium*, *Amoeba* and *Monocystis*, *Foraminifera*.

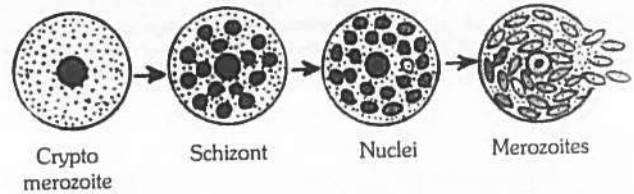


Fig : 6.1-4 Multiple fission of malarial parasite in RBC of man

Mode of multiple fission : Sometimes, the nucleus divides several times by amitosis to produce many nuclei, which is not followed immediately by cytokinesis. Later, each nucleus gathers a small amount of cytoplasm around it and the mother individual splits into many tiny daughter cells.

In course of time, each of these daughter cells starts a free life and transforms into an adult individual. This kind of fission is called multiple fission.

(a) **Encystation :** In response to unfavourable living condition, an *Amoeba* withdraws its pseudopodia and secretes a three-layered hard covering or cyst around itself. This phenomenon is termed as encystation.

(b) **Sporulation :** During favourable condition, the encysted *Amoeba* divides by multiple fission and produces many minute amoebae or pseudopodiospores; the cyst wall bursts out, and the spores are liberated in the surrounding medium to grow up into many amoebae. This phenomenon is known as sporulation.

(c) **Schizogony :** It is a type of multiple fission present in plasmodium. Schizogonies are of two type. Liver schizogony and RBC schizogony.

(iii) **Plasmodium :** Plasmodium is the division of a multinucleate protozoan into several small, multinucleate daughters without nuclear division. The daughters grow and regain the normal number of nuclei by nuclear divisions. It takes place in *Opalina* and *Pelomyxa*.

(iv) **Budding :** Formation of a daughter individual from a small projection, the bud, arising on the parent body is called budding. It is a common method of asexual reproduction. In budding new individual form by mitosis. Examples – Budding occurs in some protozoans and certain lower animals such as sponges (*Scypha*), coelenterates (*Hydra*), annelids (*Chaetopterus*) and tunicates (*Salpa*).

Types of budding : There are two types of budding

(a) **Exogenous or External budding :** Initially, a small outgrowth of the parent's body develops into a miniature individual. It then separates from the mother to lead a free life. This type of budding is recognised as exogenous budding. Example – *Hydra*.

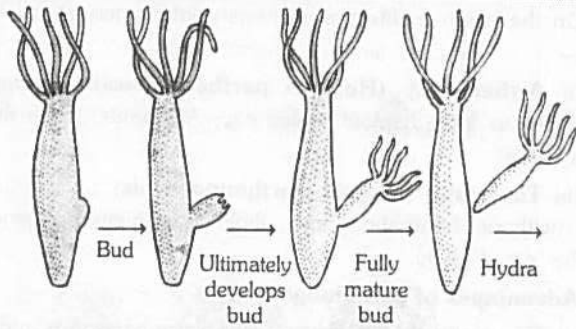


Fig : 6.1-5 External budding in hydra

(b) **Endogenous or Internal budding** : In fresh water sponges (e.g., *Spongilla*) and marine sponge (e.g., *Sycon*), the parent individual releases a specialised mass of cells enclosed in a common opaque envelope, called the gemmule, on germination. Each gemmule gives rise to an offspring gemmules are thought to be internal buds. This type of budding is recognised as endogenous budding. Example – *Sycon* and *Spongilla*.

(v) **Fragmentation** : It is the breaking up of an animal's body into two or more pieces, each of which grows into a new individual. Examples – It occurs in the flatworm, microstomum.

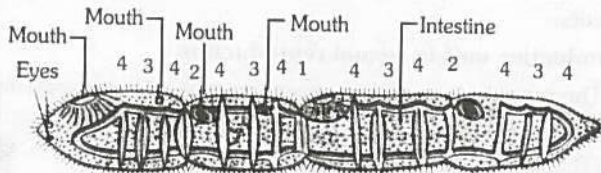


Fig : 6.1-6 Fragmentation in microstomum (a flatworm)

Special asexual reproductive bodies : Archaeocytes of sponges are totipotent cells. They take part in the formation of gemmules. Gemmules form new sponges.

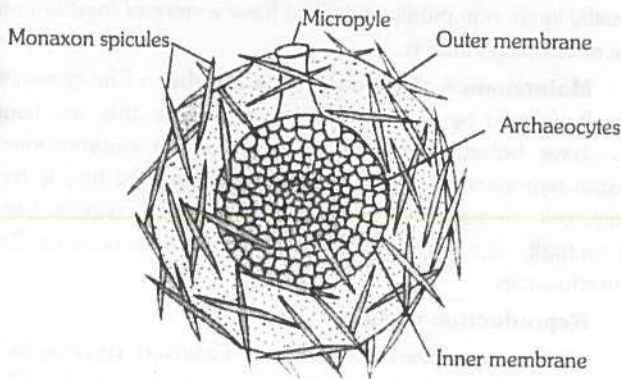


Fig : 6.1-7 A gemmule

Reproductive units in asexual reproduction : Reproductive units vary in different forms of asexual reproduction. These are entire parent bodies in binary and multiple fission's and are small parts of parent body in budding and fragmentation. An asexual reproductive unit is called blastos.

Characteristics of asexual reproduction : All forms of asexual reproduction have certain common basic features. These are under :

- A single parent produces offspring, that is, asexual reproduction is uniparental.
- Gametes are not formed.

(iii) Cell divisions are only mitotic.

(iv) The new individuals formed are usually genetically identical to the parent. Variability, if it occurs, is restricted to mutation only.

(v) Multiplication occurs rapidly.

(vi) The offspring are often formed in large numbers near the parent.

Significance of asexual reproduction : Asexual reproduction brings multiplication of the species only. It does not play a role in evolution as no variation is introduced into the new individuals formed by it. Asexual reproduction is theoretically most advantageous in stable, favourable environment because it perpetuates successful genotypes precisely.

(2) Sexual reproduction

Definition : It is the production of offspring usually by two parents, male and female. Involving four processes :

- Formation of special haploid cells, the gametes, by meiosis. (Gametogenesis)
- Fusion of the gametes in pairs, forming diploid cells, the zygotes (Fertilization)
- Repeated mitotic divisions of zygotes to form embryos (Embryogenesis)
- Growth of Embryos into a new individual (Development)

☐ Sexual reproduction is also called syngensis.

Occurrence : Sexual reproduction occurs nearly in all animals, including those which reproduce asexually. Some protozoans, such as *Amoeba*, *Euglena* lack sexual reproduction. In male and female, and the difference between them is determined genetically. In sexual reproduction offsprings resemble the parent.

Types : Sexual reproduction is of two main types –

(i) **Amphigony** : It involves the complete and permanent fusion of two gametes from different or from the same parent to form a composite cell, the zygote. It is further of two kinds :

(a) **Syngamy** : It involves the fusion of two entire gametes to form a zygote. The fusion nucleus of zygote called synkaryon. It is further of two types with regard to the source of fusing gametes :

☐ **Endogamy** : It involves self-fertilization, i.e., the fusion of two gametes of the same parent. It is, thus uniparental. e.g., *Taenia*.

☐ **Exogamy** : It involves cross-fertilization, i.e., the fusion of two gametes formed by different parents. It is, thus, biparental. e.g., frog rabbit and man. Syngamy is also of two kinds :

☐ **Isogamy** : The fusing gametes are similar morphologically as in *Monocystis* (a protozoans). Such gametes are known as isogametes, and their fusion is termed isogamy. Although the isogametes are similar in structure, they have behavioural differences. e.g., foraminifera, *monocystis*.

☐ **Anisogamy or Heterogamy** : The fusing gametes are different in form, size structure and behaviour as in frog and humans. Such gametes are known as anisogametes, or heterogametes, and their fusion is termed anisogamy, or heterogamy. e.g., *Plasmodium*, vertebrates.

Special forms of syngamy : There are three special forms of syngamy :

(a) **Neoteny :** Neoteny refers to "retention of a larval or embryonic trait in adult body". e.g., Retention of larval gills in some adult salamander.

(b) **Paedogenesis or pedomorphosis :** Paedogenesis refers to "development of gonads and production of young ones by larva" e.g., salamander Axolotl larva, liver fluke Redia larva, and gall fly.

(c) **Polyembryony :** The blastomeres formed by division of the zygote separate in early stages of development, each producing in a complete individual (fasciola liver fluke). Armadillo regularly produces 4-8 young ones per zygote. Identical twins in human being is another example.

(ii) **Conjugation :** Some acellular protist animals (e.g., Paramecium) exhibit sexual reproduction by forming male and female gamete nuclei, which they exchange through temporary cytoplasmic bridge; later, the cytoplasmic bridge disappears and the gamete nucleus of one individual fuses with that of the other to form zygote nuclei. This mode of sexual reproduction is known as conjugation.

Parthenogenesis (Virgin birth)

It is a modification of sexual reproduction in which an egg develops into a complete offspring without fertilization. It is monoparental. Parthenogenesis was discovered by Bonnet (1745).

Occurrence : Parthenogenesis is found in many non vertebrates such as rotifers, aphids, bees and crustaceans. It also occur in a few vertebrates.

Types : Parthenogenesis is of two main types :

(1) **Natural parthenogenesis :** It is a regular phenomenon in the life history of some animals. It may be three type.

(i) **Complete (Obligatory) parthenogenesis :** Males are absent, females develop parthenogenetically, e.g., rotifers, Typhlina brahmia (small lizard, 15 cm long), Lacerta saxicola-armeniaca (Caucasian Rock Lizard), Cnemidophorus (Whiptail Lizards of America).

(ii) **Incomplete (cyclic) parthenogenesis :** Some animals have both sexual and parthenogenetic individuals, which may alternate. In these animals, female can produce unfertilized or fertilized eggs, depending upon environmental conditions. In Daphnia, a fresh water crustacean, female lays unfertilized eggs that develop parthenogenetically under favourable conditions, and fertilized eggs during times of environmental stress.

In honeybee, unfertilized eggs develop into male bees (drones) with haploid cells, and fertilized eggs give rise to females (queen bees and worker bees) with diploid cells.

(iii) **Paedogenetic parthenogenesis :** In certain insects, larvae lay eggs which develop parthenogenetically into a new generation of larvae. Parthenogenesis in larvae is called paedogenesis.

(2) **Artificial parthenogenesis :** Eggs of certain animals, such as annelids, molluscs, starfish, frog, hen, rabbit, etc., can be induced to develop parthenogenetically by artificial stimuli. Artificial stimuli may be (i) physical, viz., prick of a needle, electric shock, change in temperature or pH; or (ii) chemical such as addition of urea, fatty acids, ether, chloroform, to water.

On the basis of chromosome sets parthenogenesis is of two types –

(i) **Arrhenotoky (Haploid parthenogenesis) :** Haploid eggs grow to form haploid males e.g., Arachnids, some insects (honey bees).

(ii) **Thelotoky (Diploid parthenogenesis) :** Diploid eggs grow without fertilization into diploid individuals, generally females. e.g., Gall fly.

Advantages of parthenogenesis

(i) This avoids the wastage of germplasm as sperms and ova. Adult organism is devoted exclusively to feeding and reproduction so is a mode of high reproduction e.g., aphids.

(ii) There is no chance of separation of useful combination of genes by crossing over and are transmitted as such.

(iii) The offsprings are exactly similar to parents.

(iv) Haploid parthenogenesis is the direct proof of chromosomal theory of sex-determination.

Disadvantages of parthenogenesis : It stops the chances of new combinations of genes and thus avoids selection in population. It decreases the chances of adaptability followed by extinction.

Reproductive unit in sexual reproduction

The reproductive units in sexual reproduction are specialised cells called gametes. The gametes are generally of two kinds –

(1) Microgametes or Spermatozoa

(2) Macrogametes or Ova

Both are well developed for their role in reproduction. The male gametes are mostly minute and motile so that they may swim to the female gametes for fertilization. The female gametes are usually large, non motile and often have a store of food to nourish the developing embryo.

Maintenance of chromosome number : The gametes are usually formed by meiotic divisions. Therefore, they are haploid, i.e., have halved or reduced (n) number of chromosomes. In sexual reproduction, the male and female gametes fuse to form a single cell, the zygote formed by the fusion of two haploid gametes in naturally diploid, i.e., has double or normal number (2n) of chromosomes.

Reproduction pattern

(1) **External fertilization and External development :**

This pattern is found in many aquatic animals, such as Obelia, Nereis, all bony fishes and frogs. Parents release sperms and eggs into the surrounding water, where fertilization occurs and zygotes develop into offspring.

(2) **Internal fertilization and External development :** Sperms are passed from the male into the female with an intromittent organ, such as claspers in male shark, hemi penis in lizard, snake, crocodile and penis in mammals, or otherwise, for example, by cloacal apposition in birds, with modified arm in cuttle fish. Internal fertilization has several advantages.

Animals with internal fertilization usually produce fewer zygotes because of protection provided by egg shells or internal development.

(3) Internal fertilization and Internal development :

Internal development provides additional advantages to the embryo. The mother's body provides exactly the right chemical conditions and, in mammals, warmth and nourishment also. As the mother carries the embryo wherever she goes, it is not vulnerable to predators who attack externally developing eggs.

Characteristics of sexual reproduction : Sexual reproduction has the following important basic features –

- It is generally biparental.
- It involves formation of male and female gametes.
- Mostly there is fusion of male and female gametes (fertilization).
- Cell divisions are meiotic during gamete formation and mitotic during development of zygote into an offspring.
- The offspring are not genetically identical to the parents. They show variation as they receive characters (chromosomes) from two different parents. Sexual reproduction is, thus, a source of variety in population.

Significance of sexual reproduction : Sexual reproduction has a dual significance for the species :

- It results in multiplication and perpetuation of the species.
- It contributes to evolution of the species by introducing variation in a population much more rapidly than asexual reproduction.

Table : 6.1-2 Difference between sexual and asexual reproduction

S.No.	Asexual reproduction	Sexual reproduction
1.	It is always uniparental.	It is generally biparental.
2.	It invariably results in increase in the number of individuals.	It may not result in increase in the number of individuals.
3.	Gametes are not formed.	It always involves the formation and fusion of gametes.
4.	There is no fertilization.	Fertilization generally occurs.
5.	It involves only mitotic cell divisions.	It involves meiotic divisions during gamete formation and mitotic divisions during development of zygote into an offspring.
6.	Daughter individuals are genetically identical to the parent.	Daughter individuals genetically differ from the parents.
7.	It occurs in only lower invertebrates and lower chordates.	It occurs nearly in all animals.
8.	It contributes little to evolution.	It contributes to evolution by introducing variation in offspring.
9.	It often causes rapid increase in number.	It causes slower increase in number.

Blastogenesis and Embryogenesis : Development of the offspring from reproductive units, such as buds or fragments, in asexual reproduction is called blastogenesis. Development of the embryo from the zygote in sexual reproduction is termed embryogenesis.

Unisexual or dioecious : Organism in which the two sexes occur in different individuals, e.g., humans, mammals, birds, lizards.

Bisexual / Hermaphrodite or monoecious : Organism in which the two types of sex organs (testes and ovaries) occur in the same individual, e.g., Earthworm, Taenia, Leech, Fasciola, Myxine, Herdmania.

Deviations in the reproductive strategies : Although asexual and sexual reproductions are the two major trends of breeding, many deviations are also observed in the reproductive strategies of animals. One such variation in reproductive strategy is hermaphroditism, found in tapeworms and earthworms. Tapeworms are self-fertilising; the sperm produced in the testes of one individual can fertilise the eggs produced by the same individual. The earthworms employ cross fertilisation; the sperm of one individual fertilises the eggs of the other.

Sexual dimorphism : Differentiation in morphology of the two sexes of the same species is called sexual dimorphism. Example – Ascaris, Oryctolagus and humans etc.

Human reproductive system

In human beings, reproduction takes place by sexual method and the sexes are separate.

(1) **Sex organs :** Human are unisexual. The reproductive system of each sex consists of many organs. The latter are distinguishable into primary and secondary sex organs. Besides these, there are some accessory sex characters –

(i) **Primary sex organs :** Gonads which form gametes are called primary sex organs – testis (plural testes) in males and ovary (plural ovaries) in females. Testis produces sperms and secretes testosterone. Ovary produces ova. Maturing Graafian follicles secrete oestrogens.

(ii) **Secondary sex organs :** Sex organs, glands and ducts which do not produce gametes but are otherwise essential for sexual reproduction are known as secondary sex organs. In human male reproductive system, the secondary sex organs are vasa efferentia, epididymis, vasa deferentia, ejaculatory ducts, urethra, accessory sex glands are prostate glands, Cowper's glands seminal vesicle and penis. Secondary sex organs of a human female include fallopian tubes, uterus, vagina, external genitalia, Bartholin's gland and mammary glands are accessory sex glands.

(iii) **Accessory / External / Secondary sex characters :** They are traits which do not have any direct role in reproduction but provide specific features and structures to the two sexes. The important external / accessory sex characters of human male are beard, moustaches, body hair on shoulder and chest, pubic hair on both lateral and vertical directions, comparatively more height with more muscular body, larynx apparent externally, voice low pitched with breathing more by means of diaphragm. The important accessory sex character of human females are high pitched voice, breast, broader pelvis, lateral pubic hair, rounded body contours with more subcutaneous fat in thighs, buttocks and face and sternal breathing.

□ **Puberty :** Beginning of sexual maturity or ability to reproduce is known as puberty. Puberty occurs at the age of 10 – 14 years in girls and 13 – 15 years in boys.

(2) Characteristics of human reproduction :

- (i) Human beings are non-seasonal breeders.
- (ii) There is no oestrus / heat.
- (iii) In human females the ability to produce young ones begins at menarche (beginning of menses) and ends at menopause (stoppage of menses).
- (iv) In human females the reproductive phase has 28 day repeated menstrual cycle.
- (v) Fertilization is internal.
- (vi) There is vivipary, i.e., giving birth to young ones.
- (vii) Foetus develops inside uterus and is nourished by joint special structure called placenta.
- (viii) Infants can be fed on mother's milk.
- (ix) Parental care is very well developed.

Reproduction in Flowering Plants

Reproduction is the process of formation of new individuals from pre-existing ones. It is the means of multiplication and perpetuation of the species because the older individuals of each species undergo senescence and die. There are two basic types of reproduction : Asexual and Sexual.

Asexual reproduction

The methods of reproduction which do not involve meiosis and fertilization are known as apomixis or asexual reproduction. Only mitotic divisions are involved in these methods, resulting into the formation of offsprings which are genetically similar to the parent plant.

Asexual reproduction is of following two types :

(1) **Agamospermy** : Agamospermy is a kind of plant apomixis in which the embryos and seeds are formed by asexual reproductive methods without involving meiotic gametogenesis and sexual fusion of gametes. It occurs widely in ferns and the flowering plants. There are three different types of agamospermy :

(i) **Adventive embryony** : Formation of embryo directly from the diploid sporophytic cells (nucellus or integument) of ovule is called adventive embryony. Such embryos are formed without involving meiosis and sexual fusion, e.g., *Citrus*, *Opuntia*, etc. In *Citrus*, a seed may possess upto 40 embryos (one normal and rest adventive).

(ii) **Diplospory** : In this case, the archesporium differentiates but megaspore mother cell directly gives rise to an unreduced (i.e., without meiosis) embryo sac. It may produce two types of embryos:

(a) **Diploid parthenogenesis** : Embryo develops from unfertilized diploid egg.

(b) **Diploid apogamy** : Embryo develops from any diploid cell of embryo sac except egg.

(iii) **Apospory** : It is the formation of complete embryo sac from the sporophytic cell without meiosis so that the gametophyte remains diploid. Apospory may be of two types :

(a) **Somatic apospory** : Embryo sac is formed from somatic cell.

(b) **Generative apospory** : Embryo sac is formed from archesporium without meiosis.

(2) **Vegetative propagation** : Regeneration or Formation of a new individual from any vegetative part of the body is called vegetative reproduction or vegetative propagation. The lower plants reproduce vegetatively through budding, fission, fragmentation, gemmae, resting buds, spores, etc. It is very common mode of reproduction and it may be natural vegetative propagation or artificial vegetative propagation.

(i) **Natural methods of vegetative propagation** : In natural vegetative propagation, a portion gets detached from the body of mother plant and it grows into a new individual plant under suitable conditions. Different plant parts are variously modified for vegetative propagation. Some of these are given below.

(a) **Vegetative propagation by stems** : The modified stems like bulbs, runners, rhizomes, corms, tubers, offsets, etc., help the plant to multiply under favourable conditions.

(b) **Vegetative propagation by roots** : The roots of some woody plants produce shoots which grow into new plants; e.g., *Murraya*, *Lebeck tree (Albizia)*, *Sisham (Dalbergia sisso)*, etc. Modified tuberous roots of *Sweet potato*, *Asparagus*, *Dahlia*, *Tapioca*, *Tinospora*, etc. develop buds and each of which form a new plant.

(c) **Vegetative propagation by leaves** : The leaves generally do not help in vegetative propagation. However, in *Bryophyllum pinnatum* and *B. daigremontianum*, develop along the leaf margins which on deattachment produce independent plants. In elephant ear plant (*Begonia*) also, leaf buds are produced from petiole and veins throughout the surface of the leaf. Walking fern propagates through leaf tips.

(d) **Vegetative propagation by reproductive parts** : Flowers are primarily associated with sexual reproduction. But in *Globba*, *American aloe (Agave)*, *Onion (Allium cepa)*, etc. special multicellular structures, called *bulbils*, occur on the stem. These are the modifications of axillary buds. Bulbils grow into new plants when shed from the mother plant.

(ii) **Artificial methods of vegetative propagation** : Several methods of vegetative propagation are man made and developed by plant growers and horticulturists for commercial production of crops. They are called artificial methods. In this method a portion is separated from the body of the plant and then it is grown independently. Some of the artificial methods are given below :

(a) **Cuttings** : The small piece of any plant organ (stem, root or leaf) used for propagation is called cutting. Leaf cuttings are used to propagate *Sansevieria*, *Begonia*, *Bryophyllum*, *Glocinia* and *Kalanchoe*. Root cuttings are used to propagate *Citron* and *Tamarind*. Stem cuttings are most commonly used for artificial propagation. When cuttings (about 20-30 cm. long pieces of stem)

from such plants are put into the moist soil, they develop adventitious roots and buds at the base which develops into new plants. Grapes, Sugarcane, Rose, *Bougainvillea*, Carnation, Coleus, Duranta, etc. are propagated by stem cuttings.

(b) **Layering** : In this method, roots are artificially induced on the stem branches while it is still attached to the parent plant for propagation. There are two common types of layering :

□ **Mound layering** : In this technique a lower branch of stem is bent and covered in such a way that the tip of the branch remains above the ground. After a few days, the covered part of the stem produces adventitious roots. At this stage the branch is cut off from the parent plant and it grows into a new plant. This method is commonly employed for propagating Strawberry, Jasmine, Grape vine, Raspberry, etc.

□ **Air layering (Gootee)** : This is employed in plants with thick branches which can not be easily bent. In this method, part of the stem is girdled (i.e., a ring of bark is removed) or slit at an upward angle. This part is covered with moist moss or cotton and enclosed in a polythene bag to prevent drying. The wrapped portion is called *gootee*. The roots appear after sometime and at that stage the branch is cut and planted. It grows into a new individual. This method is used in vegetative propagation of Litchi, Pomegranate, Orange, Lemon, Guava, *Bougainvillea*, etc.

(c) **Grafting** : A new variety produced by joining parts of two different plants is called grafting. The rooted shoot of one plant, called *stock*, is joined with a piece of shoot of another plant known as *scion*. The root stock is generally derived from a plant resistant to diseases and efficient in water and mineral absorption. The scion is a stem cutting from a superior quality plant. The grafting ends of both, stock and scion are cut obliquely and then placed over one another in such a way that the cambium of two come in close contact. The two pieces are firmly held together by tape, rubber tubing, etc. This results in fusion of cambium and formation of new vascular tissue. Grafting is generally done between the related varieties or species. This method has been practised for many economically useful plants, such as Rose, Mango, Apple, Pear, Guava, Citrus, Rubber etc. There are various methods of grafting like tongue or whip grafting, wedge grafting and crown grafting. Besides these a technique, called bud grafting, in which only a single bud along with a small portion of bark having intact cambium instead of a scion is employed for propagation.

(d) **Propagation by plant tissue culture or Micropropagation** : This method includes propagation of plants by culturing the cells, tissues and organs called **tissue culture**. Small pieces of plant organs or tissues are grown aseptically in a suitable nutrient medium. Initially it results in the formation of undifferentiated mass of cells called *callus* which later differentiates to produce a large number of plantlets. These plantlets are then transferred to separate pots or nursery beds to obtain a large number of plants. Tissue culture technique is useful in obtaining virus free plants, homozygous diploids and in commercial micropropagation of Orchids, Carnation, *Gladiolus*, *Chrysanthemum* and other Ornamental plants. This method is also employed for quick multiplication of plants.

T Tips & Tricks

- ✍ The asexual process replaced by the sexual method is known as apomixis.
- ✍ No natural death in organisms showing binary fission e.g., Amoeba, so are called immortal.
- ✍ Protandry : Spermatozoa mature earlier than ova in bisexual animals e.g., – Hydra, Earthworm.
- ✍ Metagenesis : Alternation of sexually and asexually reproducing forms in the life cycle of an animal e.g., *Obelia*.
- ✍ Protogyny : Ova mature earlier than sperm in a bisexual animal e.g., *Herdmania*.
- ✍ Strobilation : Asexual multiplication by transverse fusion and is found in *Scyphistoma* of *Aurelia* and also found in *Taenia*.
- ✍ Tissue culture technique was first thought by Haberlandt (1902) and Hanning (1908) but successful attempt was made by White (1932) in case of tomato root.
- ✍ *Cocos nucifera* is widely used in the preparation of culture medium as coconut milk.
- ✍ According to latest world development report, Japanese have longest life span (average life expectancy is 76.3 years while that of female is 82.5 years).

Ordinary Thinking

Objective Questions

Reproduction and its type

1. In *Vorticella*, the total number of micronuclei formed at the end of pre-zygotic nuclear division in female gamont is [EAMCET 2009]

(a) 4	(b) 6
(c) 8	(d) 5
2. Which one of the following glands is absent in reproductive system of rabbit [CPMT 2010]

(a) Cowper's gland	(b) Collateral gland
(c) Perineal gland	(d) Prostate gland
3. Haploid parthenogenesis among insects is shown by order

(a) Hymenoptera	(b) Homoptera
(c) Coleoptera	(d) All the above
4. A person which shows the secondary sexual characters of both male and female is called [CBSE PMT 1996; BHU 1999]

(a) Intersex	(b) Hermaphrodite
(c) Bisexual	(d) Gynandromorph
5. Gemmule formation in sponges is helpful in [AIIMS 2001]

(a) Parthenogenesis	(b) Sexual reproduction
(c) Only dissemination	(d) Asexual reproduction

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6. Product of sexual reproduction generally generates [NEET 2013]
 - (a) Large biomass
 - (b) Longer viability of seeds
 - (c) Prolonged dormancy
 - (d) New genetic combination leading to variation
 7. Which is mode of reproduction in Amoeba [RPMT 2001]
 - (a) Binary fission only
 - (b) Binary fission and multiple fission
 - (c) Binary fission and conjugation
 - (d) Multiple fission only
 8. In Earthworms, self fertilization does not occur due to [BVP 2000]
 - (a) Hypogyny
 - (b) Protogyny
 - (c) Protandry
 - (d) Epigyny
 9. Binary fission is found in [BVP 2000]
 - (a) Amoeba
 - (b) Paramecium
 - (c) Planaria
 - (d) All of these
 10. Drones in a colony of honey bees originate by [BHU 2002]
 - (a) Thelytoky
 - (b) Arrhenotoky
 - (c) Cyclic parthenogenesis
 - (d) Diploid parthenogenesis
 11. Which of the following shows the sexual dimorphism [CPMT 1998; AMU (Med.) 2000; RPMT 2001]
 - (a) Hydra and Ascaris
 - (b) Hydra and Oryctolagus
 - (c) Ascaris and Pheretima
 - (d) Ascaris and Oryctolagus
 12. Arrhenotoky is related to [Odisha JEE 2004]
 - (a) Parthenogenesis
 - (b) Wax formation
 - (c) Both (a) and (b)
 - (d) None of these
 13. Fertilization is internal in [MP PMT 2000]
 - (a) Toads
 - (b) Frogs
 - (c) Dog fish
 - (d) Cat fish
 14. Natural parthenogenesis occurs in [CPMT 1994; BHU 1995, 2004]
 - (a) Frog to form female
 - (b) Honeybee to produce drones
 - (c) Cockroach
 - (d) Vegetarian eggs
 15. Which type of reproduction is found in Hydra [RPMT 2000]
 - (a) Polyembryony
 - (b) Sexual and asexual
 - (c) Parthenogenesis
 - (d) Encystment
- ### Asexual reproduction/Vegetative propagation
1. Apomixis in plant means development of a plant [BHU 2008]
 - (a) From root cuttings
 - (b) Without fusion of gametes
 - (c) From fusion of gametes
 - (d) From cuttings of stem
 2. Consider the following statements and choose the correct option [Kerala PMT 2009]
 - (i) The genetic constitution of a plant is unaffected in vegetative propagation
 - (ii) Rhizome in ginger serves as an organ of vegetative reproduction
 - (iii) Totipotency of cells enables us to micropropagate plants
 - (a) Statements (i) and (ii) alone are true
 - (b) Statements (ii) and (iii) alone are true
 - (c) Statement (ii) alone is true
 - (d) Statement (iii) alone is true
 - (e) All the three statements [(i) (ii) and (iii)] are true
 3. Vegetative propagation in mint occurs by [CBSE PMT 2009]
 - (a) Runner
 - (b) Offset
 - (c) Rhizome
 - (d) Sucker
 4. The part which is grafting on stalk of another tree is called [HPMT 2005]
 - (a) Graft
 - (b) Bulbil
 - (c) Bud
 - (d) scion
 5. Vegetative propagation in Pistia occurs by [CBSE PMT (Mains) 2010]
 - (a) Stolen
 - (b) Offset
 - (c) Runner
 - (d) Sucker
 6. Which one of the following plants does not help in vegetative propagation by leaves [MHCET 2015]
 - (a) Begonia
 - (b) Kalanchoe
 - (c) Bryophyllum
 - (d) Oxalis
 7. Among the following which one is not a method of vegetative propagation
 - (a) Budding
 - (b) Layering
 - (c) Sowing
 - (d) Tissue culture
 8. After culturing the anther of a plant, a few diploid plants were found along with haploid plants. The diploid plants could have arisen from [AIIMS 1993]
 - (a) Generative cell of pollen
 - (b) Cells of anther wall
 - (c) Vegetative cell of pollen
 - (d) Exine of pollen wall
 9. Reproducing new plants by cells instead of seeds is known as [MP PMT 1994]
 - (a) Biofertilizer
 - (b) Mutation
 - (c) Tissue culture
 - (d) Antibiotics
 10. The development of a sporophyte without fertilization from the vegetative cells of the gametophyte is called [BHU 1994; AFMC 1994, 2002, 12; AIIMS 2001]
 - (a) Zygosporangium
 - (b) Aplanosporangium
 - (c) Aposporangium
 - (d) Apogamy
 11. Genetically identical progeny is produced when an individual [AFMC 1994]
 - (a) Practices self-fertilization
 - (b) Produces identical gametes
 - (c) Practices reproduction
 - (d) Practices by breeding without meiosis
 12. Which one of the following is not a natural method of vegetative propagation [MHCET 2015]
 - (a) Runner
 - (b) Foliar buds
 - (c) Stem tuber
 - (d) Grafting

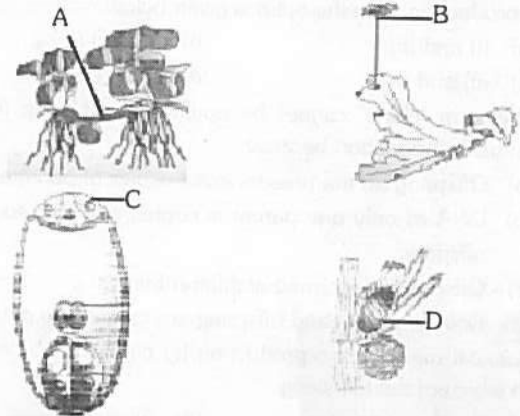
13. Formation of a sporophyte from gametophyte and vice versa is termed as [RPMT 1997]
 (a) Sexual reproduction (b) Asexual reproduction
 (c) Alternation of generation (d) Transformation
14. The plant material which is widely used in the preparation of culture medium is [AIIMS 1998; MHCET 2001; KCET 2011]
 (a) *Cycas revoluta* (b) *Cocos nucifera*
 (c) *Pinus longifolia* (d) *Borassus flabellifer*
15. Development of embryo from the cells of the nucellus is called [BHU 1999; MHCET 2001; KCET 2011; MP PMT 2012]
 (a) Parthenocarpy (b) Apocarpy
 (c) Adventive embryony (d) Apospory
16. The development of gametophyte from the vegetative parts of the sporophyte without the intervention of spores is called [CPMT 1999; BHU 1999]

Or

- The formation of gametophyte from the sporophyte (without meiosis) is called [AMU (Med.) 2005; BHU 2008]
 (a) Parthenocarpy (b) Parthenogenesis
 (c) Apogamy (d) Apospory
17. To get haploid callus, one can culture [CBSE PMT 2001]
 (a) Embryo (b) Leaf tissue
 (c) Stigma (d) Pollen grain
18. The reason of formation of embryoid from pollen grain in a tissue culture medium is [CBSE PMT 2002]
 (a) Organogenesis (b) Double fertilization
 (c) Test tube culture (d) Cellular totipotency
19. Which of the following propagates through leaf-tip [CBSE PMT 2004]
 (a) *Marchantia* (b) Moss
 (c) Walking fern (d) Sprout-leaf plant
20. Grafting of tissue or organ between individuals of different species is called [NCERT; Kerala PMT 2004; J & K CET 2010]
 (a) Autograft (b) Isograft
 (c) Xenograft (d) Allograft
 (e) Intergraft
21. One of the plants using 'Foliar adventitious buds' as method for vegetative propagation is [AIEEE Pharmacy 2004; AFMC 2012]
 (a) Banana (b) Ginger
 (c) *Bryophyllum* (d) *Calocasia*
22. In which one pair both the plants can be vegetatively propagated by leaf pieces [AIEEE Pharmacy 2004; CBSE PMT 2005; J & K CET 2010]
 (a) *Bryophyllum* and *Kalanchoe*
 (b) *Chrysanthemum* and *Agave*
 (c) *Agave* and *Kalanchoe*
 (d) *Asparagus* and *Bryophyllum*
23. In a type of apomixis known as adventive embryony, embryos develop directly from the [CBSE PMT 2005]
 (a) Nucellus or integuments
 (b) Synergids or antipodals in a embryo sac
 (c) Accessory embryo sacs in the ovule
 (d) Zygote

24. Stem cuttings are commonly used for the propagation of [BHU 2005]
 (a) Banana (b) Rose
 (c) Mango (d) Cotton
25. Carrot is micropropagated through [HPMT 2005]
 (a) Embryo (b) Embryoids
 (c) Shoot culture (d) Callus
26. Examine the figures (A-D) given below and select the right option out of a-d, in which all the four structures A, B, C and D are identified correctly

Structures:

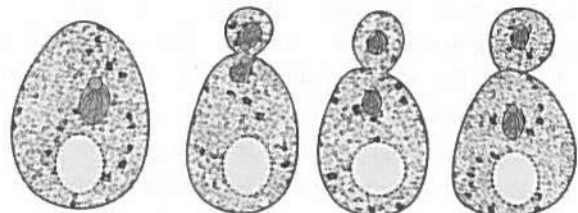


Options:

[CBSE PMT (Mains) 2010]

	A	B	C	D
(a)	Rhizome	Sporangiophore	Polar cell	Globule
(b)	Runner	Archegoniophore	Synergid	Antheridium
(c)	Offset	Antheridiophore	Antipodals	Oogonium
(d)	Sucker	Seta	Megaspore mother cell	Gemma cup

27. What is common between vegetative reproduction and Apomixis [CBSE PMT (Mains) 2011]
 (a) Both occur round the year
 (b) Both produces progeny identical to the parent
 (c) Both are applicable to only dicot plants
 (d) Both bypass the flowering phase
28. The given diagram refers to which type of reproduction in yeast [NCERT]



- (a) Layering (b) Budding
 (c) Binary fission (d) Fusion
29. Name the plant shows adventive embryonic cells [GUJCET 2015]
 (a) Sunflower and Mango (b) Citrus and Mango
 (c) Lemon and Maize (d) Lemon and Palms

NQ NCERT

Exemplar Questions

1. A few statements describing certain features of reproduction are given below

- (i) Gametic fusion takes place
- (ii) Transfer of genetic material takes place
- (iii) Reduction division takes place
- (iv) Progeny have some resemblance with parents

Select the options that are true for both asexual and sexual reproduction from the options given below [NCERT]

- (a) (i) and (ii)
- (b) (ii) and (iii)
- (c) (ii) and (iv)
- (d) (i) and (iii)

2. The term 'clone' cannot be applied to offspring formed by sexual reproduction because [NCERT]

- (a) Offspring do not possess exact copies of parental DNA
- (b) DNA of only one parent is copied and passed on to the offspring
- (c) Offspring are formed at different times
- (d) DNA of parent and offspring are completely different

3. Asexual method of reproduction by binary fission is common to which of the following

- (i) Some eukaryotes
- (ii) All eukaryotes
- (iii) Some prokaryotes
- (iv) All prokaryotes

Choose the correct option from the following [NCERT]

- (a) (i) and (ii)
- (b) (ii) and (iii)
- (c) (i) and (iii)
- (d) (iii) and (iv)

4. A few statements with regard to sexual reproduction are given below

- (i) Sexual reproduction does not always require two individuals

- (ii) Sexual reproduction generally involves gametic fusion
- (iii) Meiosis never occurs during sexual reproduction
- (iv) External fertilisation is a rule during sexual reproduction

Choose the correct statements from the options below

[NCERT]

- (a) (i) and (iv)
- (b) (i) and (ii)
- (c) (ii) and (iii)
- (d) (i) and (iv)

5. A multicellular, filamentous alga exhibits a type of sexual life cycle in which the meiotic division occurs after the formation of zygote. The adult filament of this alga has [NCERT]

- (a) Haploid vegetative cells and diploid gametangia
- (b) Diploid vegetative cells and diploid gametangia
- (c) Diploid vegetative cells and haploid gametangia
- (d) Haploid vegetative cells and haploid gametangia

6. The male gametes of rice plant have 12 chromosomes in their nucleus. The chromosome number in the female gamete, zygote and the cells of the seedling will be, respectively

[NCERT]

- (a) 12, 24, 12
- (b) 24, 12, 12
- (c) 12, 24, 24
- (d) 24, 12, 24

7. Given below are a few statements related to external fertilization. Choose the correct statements

- (i) The male and female gametes are formed and released simultaneously
- (ii) Only a few gametes are released into the medium
- (iii) Water is the medium in a majority of organisms exhibiting external fertilization
- (iv) Offspring formed as a result of external fertilization have better chance of survival than those formed inside an organism

Choose the correct option

[NCERT]

- (a) (iii) and (iv)
- (b) (i) and (iii)
- (c) (ii) and (iv)
- (d) (i) and (iv)

8. The statements given below describe certain features that are observed in the pistil of flowers

- (i) Pistil may produce more than one seed
- (ii) Each carpel may have more than one ovule
- (iii) Each carpel has only one ovule
- (iv) Pistil have only one carpel

Choose the statement that are true from the options below

[NCERT]

- (a) (i) and (ii)
- (b) (i) and (iii)
- (c) (ii) and (iv)
- (d) (iii) and (iv)

9. Which of the following situations correctly describe the similarity between an angiosperm egg and a human egg

- (i) Eggs of both are formed only once in a lifetime
- (ii) Both the angiosperm egg and human egg are stationary
- (iii) Both the angiosperm egg and human egg are mobile
- (iv) Syngamy in both results in the formation of zygote

Choose the correct answer from the options given below

[NCERT]

- (a) (ii) and (iv)
- (b) (iv) only
- (c) (iii) and (iv)
- (d) (i) and (iv)

10. Appearance of vegetative propagules from the nodes of plants such as sugarcane and ginger is mainly because [NCERT]

- (a) Nodes are shorter than internodes
- (b) Nodes have meristematic cells
- (c) Nodes are located near the soil
- (d) Nodes have non-photosynthetic cells

11. Which of the following statements, support the view that elaborate sexual reproductive process appeared much later in the organic evolution

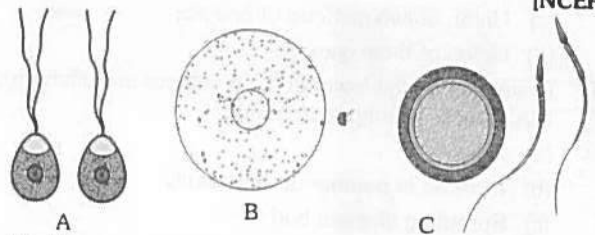
- (i) Lower groups of organisms have simpler body design
- (ii) Asexual reproduction is common in lower groups
- (iii) Asexual reproduction is common in higher groups of organisms
- (iv) The high incidence of sexual reproduction in angiosperms and vertebrates

Choose the correct answer from the options given below

[NCERT]

- (a) (i), (ii) and (iii)
- (b) (i), (iii) and (iv)
- (c) (i), (ii) and (iv)
- (d) (ii), (iii) and (iv)

12. Offspring formed by sexual reproduction exhibit more variation than those formed by Asexual reproduction because [NCERT]
- Sexual reproduction is a lengthy process
 - Gametes of parents have qualitatively different genetic composition
 - Genetic material comes from parents of two different species
 - Greater amount of DNA is involved in sexual reproduction
13. Choose the correct statement from amongst the following [NCERT]
- Dioecious (hermaphrodite) organisms are seen only in animals
 - Dioecious organisms are seen only in plants
 - Dioecious organisms are seen in both plants and animals
 - Dioecious organisms are seen only in vertebrates
14. There is no natural death in single celled organisms like Amoeba and bacteria because [NCERT]
- They cannot reproduce sexually
 - They reproduce by binary fission
 - Parental body is distributed among the offspring
 - They are microscopic
15. There are various types of reproduction. The type of reproduction adopted by an organism depends on [NCERT]
- The habitat and morphology of the organism
 - Morphology of the organism
 - Morphology and physiology of the organism
 - The organism's habitat, physiology and genetic makeup
16. Identify the incorrect statement [NCERT]
- In asexual reproduction, the offspring produced are morphologically and genetically identical to the parent
 - Zoospores are sexual reproductive structures
 - In asexual reproduction, a single parent produces offspring with or without the formation of gametes
 - Conidia are asexual structures in *Penicillium*
17. Which of the following is a post-fertilisation event in flowering plants [NCERT]
- Transfer of pollen grains
 - Embryo development
 - Formation of flower
 - Formation of pollen grains
18. The number of chromosomes in the shoot tip cells of a maize plant is 20. The number of chromosomes in the microspore mother cells of the same plant shall be [NCERT]
- 20
 - 10
 - 40
 - 15
2. Why asexual reproduction is sometimes disadvantageous [J & K CET 2012]
- It allows animals that do not move around to produce offspring without finding mates
 - It allows an animal to produce many offspring quickly
 - It saves the time and energy of gamete production
 - It produces genetically uniform populations
3. Air layering or pot layering is followed for those plants which
- Do not sucker readily
 - Do not have flexible branches
 - Both above
 - None above
4. Why inarching is an improved method of vegetative multiplication
- Seeds are not formed
 - Stock and scion remain intact
 - Improved seed formation
 - All of these
5. Identify gametes (A, B and C) respectively in given diagram [NCERT]



- Homogametes, isogametes, heterogametes
 - Isogametes, homogametes, heterogametes
 - Heterogametes, isogametes, homogametes
 - Homo/ Isogametes, heterogametes, heterogametes
6. In rabbit, ex-abdominal reproductive organs are [RPMT 2001]
- Testes, Penis, Epididymis
 - Testes, Vas deferens, Testes sac
 - Testes, Vas deferens, Ejaculatin duct
 - Testes sac, Seminal Vesicle, Epididymis
7. Virus free culture of banana can be raised from
- Apical cells
 - Pith of stem
 - Leaf lamina
 - Primary root
8. In a type of layering, the basal branch is pegged down in the soil at several places to form a number of new plants from a single branch. It is known as
- Serpentine layering
 - Air layering
 - Simple layering
 - All of these
9. One of the methods of vegetative propagation is by cutting. In woody plants roots are readily formed
- If branches are cut from juvenile stage
 - If older branches are cut from adult stage
 - If younger branches are cut from adult stage
 - There is no difference

Critical Thinking

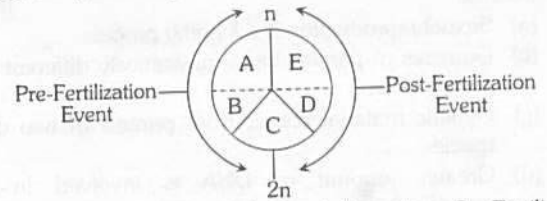
Objective Questions

1. Which of the following pairs is not correctly matched [AIPMT 2015]
- | Mode of reproduction | Example |
|----------------------|--------------------|
| (a) Rhizome | Banana |
| (b) Binary fission | <i>Sargassum</i> |
| (c) Conidia | <i>Penicillium</i> |
| (d) Offset | Water hyacinth |

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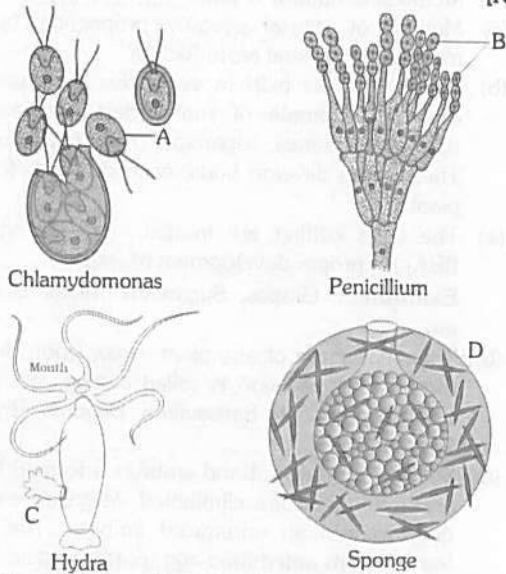
10. The group of crop plants which are vegetatively propagated is [NCERT]
 (a) Potato, Papaya, Banana
 (b) Onion, Coriander, Lime
 (c) Groundnut, Drumstick, Cashewnut
 (d) Sugarcane, Tapioca, Banana, Potato, Rose
11. Grafting of vegetable yielding plants is not done because
 (a) The variety cannot be improved
 (b) The yield cannot be improved
 (c) They are mostly herbs
 (d) They may get killed
12. Agamospermy and vegetative propagation represent
 (a) Asexual reproduction (b) Sexual reproduction
 (c) Adventive polyembryony (d) Apomixis
13. Root of sweet potato when placed in suitable soil
 (a) Undergoes fragmentation
 (b) Sprouts
 (c) Undergoes decay
 (d) Develops more adventitious roots
14. Parthenogamy represents the
 (a) Union of two vegetative nuclei
 (b) Union of two parent hyphae
 (c) Union of two gametes of one sex
 (d) Union of three gametes
15. In sugarcane, the lower ends of cuttings are often dipped in IBA prior to sowing to promote
 (a) Rooting
 (b) Increase in number of shoot buds
 (c) Sprouting of shoot bud
 (d) None of these
16. In *Sansevieria*, the mode of vegetative propagation is through
 (a) Stem cuttings (b) Leaf cuttings
 (c) Rhizome cuttings (d) None of these
17. Which of the following devices is not used by plants to prevent autogamy
 (a) Self - incompatibility
 (b) Production of unisexual flowers
 (c) Heterostyly
 (d) Production of cleistogamous flowers
18. In agamospermy, diploid embryo sac is derived from
 (a) Megaspore without meiosis
 (b) Microspore
 (c) Megaspore mother cell without meiosis
 (d) Microspore mother cell without meiosis
19. Grafting in monocots is rarely successful because
 (a) Monocots have closed vascular bundles
 (b) Monocots are without cambium
 (c) Both (a) and (b)
 (d) Both wrong
20. In vegetative propagation
 (a) Unit of reproduction is floral bud
 (b) Unit of reproduction is plant part
 (c) Seed is produced amphimictically
 (d) All the above

21. Select the right option in which the events (A, B, C, D and E) in life of general reproduction are correctly identified [NCERT]



- (a) A - Gametogenesis, B - Zygote formation, C - Fertilization, D - Gamete transfer, E - Embryogenesis
 (b) A - Gametogenesis, B - Gamete transfer, C - Fertilization, D - Zygote formation, E - Embryogenesis
 (c) A - Gamete transfer, B - Gametogenesis, C - Fertilization, D - Zygote formation, E - Embryogenesis
 (d) A - Gametogenesis, B - Gamete transfer, C - Fertilization, D - Embryogenesis, E - Zygote formation
22. The progressive development of an egg cell or an asexual reproductive body into an adult individual resembling its parent is
 (a) Ontogenic development (b) Phylogenetic development
 (c) Developmental biology (d) Blastogenesis
23. The development of a human child in the mother's womb was described in a monumental Indian book called
 (a) Ramayana (b) Vedas
 (c) Gita (d) Susruta Samhita
24. *De Generatione Animalium* was written by
 (a) Anaximander (b) Aristotle
 (c) Hippocrates (d) Empedocles
25. Sometimes, larva develops gonads and reproduces by normal sexual reproduction. It is called
 (a) Regeneration (b) Neoteny
 (c) Autotomy (d) Paedogenesis
26. Consider the following statements with respect to reproduction in the lower living organisms
 A. Organisms like yeast and *Planaria* reproduce asexually by means of budding
 B. True regeneration is observed in *Hydra*
 C. The protonema of mosses multiply by fragmentation
 D. In the unicellular organisms like bacteria algae and *Amoeba*, reproduction is synonymous with growth, i.e., increase in number of cells
 Of the above statements [Kerala PMT 2012]
 (a) A and B alone are correct (b) B and C alone are correct
 (c) A and D alone are correct (d) B and D alone are correct
 (e) C and D alone are correct
27. Match the following and choose the correct combination from the options given
- | Column I
(Organism) | Column II
(Approximate life span) |
|------------------------|--------------------------------------|
| A. Butterfly | 1. 60 years |
| B. Crow | 2. 140 years |
| C. Parrot | 3. 15 years |
| D. Crocodile | 4. 1-2 weeks |
- [Kerala PMT 2012]
 (a) A-1; B-2; C-3; D-4
 (b) A-4; B-3; C-1; D-2
 (c) A-2; B-3; C-4; D-1
 (d) A-3; B-2; C-1; D-4

28. Multiple fission occurs in Amoeba under
(a) Favourable conditions (b) Unfavourable conditions
(c) Both (a) and (b) (d) None of the above
29. Asexual reproductive body is called
(a) Egg (b) Sperm
(c) Ovum (d) Blastos
30. Paramecium reproduces by
(a) Asexual reproduction (b) Sexual reproduction
(c) Both (a) and (b) (d) None of the above
31. During binary fission and multiple fission, the cell division is
(a) Mitosis (b) Meiosis
(c) Amitosis (d) Cytokinesis
32. Identify A to D in given figures showing asexual reproductive structure [NCERT]



- (a) A - Zoospore, B - Conidiosporangium, C - Bud, D - Gemmule
(b) A - Zoospore, B - Conidia, C - Bud, D - Gemmule
(c) A - Zoogamete, B - Conidia, C - Bud, D - Gemmule
(d) A - Aplanospore, B - Conidia, C - Bud, D - Gemmule

Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

- (a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : Many plants are propagated vegetatively even though they bear seeds.
Reason : Potatoes multiply by tubers, apple by cutting. [AIIMS 2001]
2. Assertion : Asexual reproduction is also called blastogenesis.
Reason : In asexual reproduction, there is no formation and fusion of gametes.

3. Assertion : Claspers of cartilage fishes are analogous to penis of human male.
Reason : Both act as copulatory organs and transfer the sperms into female.
4. Assertion : In apomixis plants of new genetic sequence are produced.
Reason : In apomixis two individual of same genetic sequence meet.
5. Assertion : Grafting is not usually possible in monocots.
Reason : Successful grafting requires that cambia of both stock and scion fuse to form new vascular tissues.
6. Assertion : A plant biotype can be retained and multiplied indefinitely without any change or variation by the method of asexual reproduction.
Reason : Asexual reproduction does not involve meiosis and syngamy.

Answers

Reproduction and its type

1	a	2	b	3	a	4	d	5	d
6	d	7	b	8	c	9	d	10	b
11	d	12	a	13	c	14	b	15	b

Asexual reproduction/Vegetative propagation

1	b	2	e	3	d	4	d	5	b
6	c	7	c	8	b	9	c	10	d
11	b	12	d	13	c	14	b	15	c
16	d	17	d	18	d	19	c	20	c
21	c	22	a	23	a	24	b	25	d
26	c	27	b	28	b	29	b		

NCERT Exemplar Questions

1	c	2	a	3	c	4	b	5	d
6	c	7	b	8	a	9	b	10	b
11	c	12	b	13	c	14	c	15	d
16	b	17	b	18	a				

Critical Thinking Questions

1	b	2	d	3	c	4	b	5	d
6	a	7	a	8	a	9	a	10	d
11	c	12	a	13	b	14	c	15	a
16	b	17	d	18	c	19	c	20	b
21	b	22	d	23	d	24	b	25	b
26	e	27	e	28	b	29	d	30	c
31	a	32	b						

Assertion and Reason

1	a	2	b	3	a	4	d	5	a
6	a								

AS Answers and Solutions

Reproduction and its type

7. (b) Binary fission may be longitudinal or transverse. During multiple fission, the parental body divides into many daughter organisms.
8. (c) Earthworms are bisexual but self fertilization does not occur because their testes ripen first. They are protandrous.
9. (d) Binary fission occurs in *Amoeba*, *Paramecium*, and *Planaria*.
10. (b) Arrhenotoky is a type of parthenogenesis, in which the unfertilized eggs develop into males with haploid cells.
12. (a) Parthenogenesis can be classified into arrhenotoky and thelytoky.
14. (b) Parthenogenesis is the development of an individual from an unfertilized egg. In honey bees drones develop parthenogenetically.
15. (b) Both sexual and asexual type of reproduction are found in *Hydra*.

Asexual reproduction/Vegetative propagation

1. (b) The methods of reproduction which do not involve meiosis and fertilization are known as apomixis or asexual reproduction.
5. (b) *Lemna*, *Pistia*, *Eichhornia* - Offset
7. (c) Sowing is related with sexual reproduction.
14. (b) Culture medium contains minerals, vitamin, 2-4% sucrose, amino acid glycine and growth regulators (or banana pulp/ coconut milk/yeast extract).
15. (c) In adventive embryony embryo arises from diploid sporophytic cells such as nucellus or integuments (other egg) e.g., citrus.
19. (c) Walking fern (*Adiantum caudatum*) because its leaf tips when come in contact with soil, form new plants as adventitious buds develop at leaf tips.
21. (c) Foliar (on the leaf) adventitious buds are formed at place other than nodes. e.g., *Bryophyllum*.
24. (b) Stem cutting of at least one year old stem are employed in case of rose for propagation.
26. (c) A - Offset of *Eichhornia*
B - Antheridiophore of *Marchantia*
C - Antipodals
D - Oogonium (Nucule) of *Chara*

Critical Thinking

1. (b) Binary fission is usually found in amoeba, paramoecium, euglena.
3. (c) This is employed in plants with thick nonflexible branches which can not be easily bent. In this method part of the stem is girdled i.e., a ring of bark is removed. This part is covered with moist moss or cotton and enclosed in a polythene bag. The roots appear after sometime and at that stage the branch is cut and planted.

4. (b) The rooted shoot of one plant called stock is joined with a piece of shoot of another plant known as scion. The grafting ends of both stock and scion are cut obliquely and then placed over one another in such a way that the cambia of two came in close contact.
9. (a) Plants like sugarcane, grapes, rose, china rose, Bougainvillea etc are propagated by stem cuttings.
11. (c) Grafting is generally done between the related varieties or species. This method has been practised for many economically useful plants, such as rose, mango, apple, citrus, rubber etc.
12. (a) Agamospermy seed is formed without gametic union. Vegetative propagation can be of two kinds :
(i) Methods of natural vegetative propagation.
(ii) Methods of artificial vegetative propagation both are the methods of asexual reproduction.
13. (b) The roots also help in vegetative propagation some common example of root tubers are sweet potato (*Ipomoea batatas*), asparagus (*Asparagus*) and Dahlia. These roots develop buds, each of which form a new plant.
15. (a) The stem cutting are treated with rooting hormone (IBA) for proper development of roots.
Example : Grapes, Sugarcane, Rose, Bougainvillea etc.
16. (b) The small piece of any plant organ (root, stem or leaf) used for propagation is called cutting, leaf cutting are used to propagate Sansevieria, Begonia, Bryophyllum, Gloxinia etc.
18. (c) Seeds are produced and embryo is formed but meiosis and fertilization are eliminated. Megaspore mother cell develop into an unreduced embryo. The embryo is formed from unfertilized egg (parthenogenesis) or some other cells of embryo sac (apogamety).
22. (d) Development of the offspring from reproductive units such as buds or fragments in asexual reproduction is called blastogenesis. Blastogenesis have the same target to develop a new individual by the process of cell division and differentiation.
25. (b) Neoteny refers to the retention of a larval or embryonic trait in the adult body e.g. Cartilaginous skeleton in adult chondrichthyes and larval gills in some adult salamanders.
28. (b) The multiple fission is here called sporulation and the encysted products are termed spores. The spores remain inactive during unfavourable conditions such as desiccation and extremes of temperature.

Assertion and Reason

1. (a) Vegetative reproduction is asexual type of reproduction Potato, Sugarcane, Apple, etc., are multiplied by asexual means.
2. (b) Development of an organism from non-sexual reproductive units like buds fragments etc. is called blastogenesis. In asexual reproduction there is no formation and fusion of gametes.
3. (a) Claspers of cartilaginous fishes (sharks) is one pair between the pelvic fins. Claspers are analogous to penis of human male both act as copulatory organ and transfer the sperm into female.
4. (d)
5. (a)
6. (a)

Reproduction in Organisms

SET Self Evaluation Test

1. Totipotent cell refers to [CPMT 1995, 2009; Kerala CET 2003]
- An undifferentiated cells capable of developing into complete embryo
 - An undifferentiated cell capable of developing into an organ
 - An undifferentiated cell capable of developing into a system or entire plant
 - Cells which lack the capability or differentiating into an organ or system
2. Match the following
- | Column I | | Column II | |
|----------|------------------|-----------|-----------------|
| A. | Virus free | I. | Intact roots |
| B. | Root cutting | II. | <i>In vitro</i> |
| C. | <i>Dalbergia</i> | III. | Black berry |
| D. | Mound layering | IV. | Jasmine |
- A-I, B-III, C-II, D-IV
 - A-II, B-III, C-I, D-IV
 - A-II, B-I, C-III, D-IV
 - A-II, B-III, C-IV, D-I
3. An explant is a
- Plant which has totally disappeared from that area
 - Plant part which falls due to the formation of abscission layer
 - Plant part used for culturing in micropropagation/tissue culture
 - None of these
4. The fastest method to obtain clones is through
- Induced mutation
 - Parasexual Hybridization
 - Parthenogenesis
 - Vegetative reproduction
5. Morphogenesis is defined as the
- Proliferation of callus
 - Differentiation of callus into reproductive buds
 - Differentiation of callus into plant parts
 - None of these
6. To obtain naked protoplasts during somatic hybridization the enzymes needed are
- Cellulase and protease
 - Cellulase and amylase
 - Cellulase and pectinase
 - Cellulase and lipase
7. In grafting the part having the strong root system is known as
- Scion
 - Stock
 - Both (a) and (b)
 - Slice or Whip
8. Which of the following plant cell/s are totipotent
- Sieve tubes
 - Xylem vessels
 - Meristems
 - Cork cells
9. Binary fission in paramecia is
- Transverse
 - Longitudinal
 - Oblique
 - Asymmetrical
10. A great power of regeneration is found in
- Hydra*
 - Sponges
 - Planaria*
 - All the three
11. Binary fission in *Euglena* is
- Transverse
 - Longitudinal
 - Oblique
 - Unequal
12. The field of study which deals with the study of embryogenetic or blastogenetic processes by which organisms undergo progressive and orderly changes in structure and function during their entire life history is called
- Developmental biology
 - Embryology
 - Both (a) and (b)
 - Embryogenesis
13. The period of development passed within the egg or the womb of the mother is
- Post-embryonic period
 - Post-natal period
 - Pre-natal period
 - None of these
14. In which of the following animals, parthenogenesis is very common
- Monkeys
 - Hens
 - Ducks
 - Aphids
15. Syngamy is the complete and permanent fusion of two gametes. It includes
- Endogamy and Exogamy
 - Isogamy and Anisogamy
 - Both (a) and (b)
 - None of the above

Answers

1	c	2	b	3	c	4	d	5	c
6	c	7	b	8	c	9	a	10	d
11	b	12	c	13	c	14	d	15	c